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FINAL REPORT

ONE YEAR LIFE TEST OF  
1-1/2 INCH IMAGE DISSECTOR

Project No.: 5186

Date: December 13, 1965

Prepared For: Jet Propulsion Laboratory  
California Institute of  
Technology  
Pasadena, California

Prepared By: J. Z. Karpinski  
J. Z. Karpinski

Approved By: Charles F. Misso  
C.E.F. Misso, Section Head  
Electron Tube Department  
CBS Laboratories  
A Division of Columbia  
Broadcasting System, Inc.  
Stamford, Connecticut

Contract No. 950054

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## Introduction

Two image dissectors, of the type used in the Mariner IV Mars probe were continuously operated in laboratory life test equipment for a period of one year. The test was devised to simulate the loading conditions which occur with the tube in an operational mode. The changes in tube characteristics, which occurred during the test were small and well within the permitted operational range.

## Test Conditions

The tubes, each with its own current control, as shown in Figure 1, were mounted in the test equipment. The photocathodes were illuminated uniformly at a level of 0.02 foot-candles and the voltage between the second and the tenth electron multiplying dynodes was initially adjusted to give an anode signal output current of 0.1 microampere. The initial set up conditions were maintained throughout the test. The operational conditions were checked and the anode signal and dark currents were recorded at weekly intervals, throughout the test.

General conditions of test were as follows:

Light source color temperature 2870°K

Photocathode illumination 0.02 ft.-candles

Area of photocathode 0.01667 square feet.

The tube potentials were adjusted as follows:

Photocathode - 700 volts\*

Focus electrode - 630 volts\*

with respect to aperture (Dynode #1)

The voltage between Dynode #1 and Dynode #10 was initially adjusted to an anode current of 0.1 microamperes and thereafter fixed at that value. The voltages between D10 and D11, D11 and D12 and anode were set at 125 volts.

The measurements listed in Table I were made before and after the year's life test. For these measurements the overall image section and electron multiplier voltages were 700 and 1500 volts respectively.

#### Test Data Evaluation

Figures 2 and 3 show the variations in anode signal and dark currents which occurred during the test.

#### Tube #M1083

The curves of Tube #M1083 in Figure 2 show that the overall sensitivity and the dark current of the tube increased by a factor of  $\approx 2.5$  during the year's operation. However, the test figures in Table I do not substantiate this since these indicate that the total change which occurred during the test was in the order of 20%.

A thorough investigation of the latest test measurements and a life test equipment check did not reveal any anomalous conditions. A redistribution of the electron multiplier interdynode potentials between Dynode #1 and Dynode #10 was considered. However, calculations made with the aid of secondary emission curves generated from tube data could not account for the 170% increase. Since both tubes were operated together in the same box the increase cannot be attributed to the light source variation. Thus

we are led to the belief that a malfunction occurred during the test prior to the one year operational cycle.

#### Tube #1089

During the life test period the signal current of Tube #M1089 increased by 10%. According to the data in Table III the overall sensitivity increased by 40%. The differences in these measurement ~ 30% can be attributed to small changes in instruments and filter factors and in particular to the difficulties encountered in making very precise measurements.

#### Conclusions

The ability of the CBS Type CL1228 Image Dissector tubes to operate continuously for one year under simulated application conditions was demonstrated. The small changes in performance characteristics, observed during the life test, indicate that this type of tube is highly suitable for extended space missions.

TABLE I

	TUBE NO.			
	<u>M1083</u>		<u>M1089</u>	
	Before Life Test	After Life Test	Before Life Test	After Life Test
PC Sensitivity	32 $\mu$ A/Lumen	42 $\mu$ A/Lumen	34.5 $\mu$ A/Lumen	42 $\mu$ A/Lumen
PC uniformity	88.5%	88%	90%	90%
Dynode Uniformity	85%	79%	85%	79%
Gain	4 x 10 <sup>6</sup>	3.7 x 10 <sup>6</sup>	23.4 x 10 <sup>6</sup>	26 x 10 <sup>6</sup>
Anode Dark Current	.005 $\mu$ A	.01 $\mu$ A	.03 $\mu$ A	.03 $\mu$ A
Anode Sensitivity	128 A/Lumen	156 A/Lumen	785 A/Lumen	1090 A/Lumen



TABLE II

ONE YEAR LIFE TEST

PROJECT 5186

Type CL1228 Image Dissector

TUBE NO. M 1083

POSITION NO. 4

<u>Date</u>	Anode Current $\mu$ A	Dark Current $\mu$ A
10/20/64	0.1	0.01
10/21/64	0.1	0.01
10/22/64	0.1	0.01
10/24/64	0.1	0.01
10/26/64	0.1	0.01
10/27/64	0.1	0.01
10/29/64	0.1	0.01
11/2/64	0.105	0.01
11/5/64	0.11	0.01
11/10/64	0.11	0.01
11/16/64	0.11	0.01
11/21/64	0.11	0.01
11/30/64	0.11	0.01
12/7/64	0.11	0.01
12/14/64	0.14	0.015
12/21/64	0.11	0.012
12/28/64	0.15	0.02
1/4/65	0.15	.016
1/14/65	0.14	.015
1/21/65	0.13	.013
1/28/65	0.13	.013
2/4/65	0.14	.012
2/11/65	.14	.014
2/18/65	.14	.014
2/25/65	.14	.014
3/4/65	.14	.012
3/11/65	.16	.012
3/18/65	.16	.012
3/25/65	.16	.012
4/1/65	.16	.014
4/8/65	.16	.016
4/15/65	.18	.020
4/22/65	.18	.020
4/29/65	0.19	.016

TABLE II - continued

<u>Date</u>	Anode Current $\mu$ A	Dark Current $\mu$ A
5/6/65	.19	.015
5/13/65	.19	.01
5/20/65	.19	.016
5/27/65	.195	.018
6/3/65	.195	.015
6/10/65	.200	.016
6/17/65	.210	.016
6/24/65	.210	.018
7/1/65	.220	.020
7/8/65	.220	.020
7/15/65	.210	.019
7/21/65	.210	.020
7/29/65	.220	.017
8/5/65	.230	.021
8/12/65	.230	.022
8/19/65	.220	.024
8/26/65	.235	.023
9/2/65	.230	.020
9/9/65	.220	.018
9/16/65	.240	.022
9/23/65	.260	.024
9/30/65	.265	.021
10/7/65	.260	.018
10/14/65	.260	.020
10/21/65	.260	.019
10/28/65	.280	.020
11/4/65	.270	.020
11/11/65	.290	.024

TABLE III

ONE YEAR LIFE TEST PROJECT 5186  
 Type CL1228 Image Dissector TUBE NO. M1089  
 POSITION NO. 2

<u>Date</u>	Anode Current $\mu$ A	Dark Current $\mu$ A
10/26/64	0.1	.01
10/27/64	0.1	.01
10/29/64	0.1	.01
11/2/64	0.11	.01
11/5/64	0.11	.01
11/10/64	0.11	.01
11/16/64	0.12	.01
11/21/64	0.12	.01
11/30/64	0.12	.01
12/7/64	0.12	.01
12/14/64	0.11	.02
12/21/64	0.12	.012
12/28/64	0.12	.014
1/4/65	0.12	.011
1/14/65	0.11	.0076
1/21/65	0.13	.0068
1/28/65	0.13	.0072
2/4/65	0.11	.005
2/11/65	.13	.0088
2/18/65	.12	.0087
2/25/65	.12	.0077
3/4/65	.11	.0072
3/11/65	.11	.007
3/18/65	.11	.0073
3/25/65	.11	.0066
4/1/65	.10	.0081
4/8/65	.10	.009
4/15/65	.096	.0011
4/22/65	.095	.0011
4/29/65	.11	.0027
5/6/65	.11	.003
5/13/65	.10	.0044
5/20/65	.105	.0076
5/27/65	.10	.0085

TABLE III - continued

<u>Date</u>	Anode Current $\mu\text{A}$	Dark Current $\mu\text{A}$
6/3/65	.10	.0074
6/10/65	.10	.0070
6/17/65	.10	.006
6/24/65	.10	.0099
7/1/65	.10	.0090
7/8/65	.10	.011
7/15/65	.10	.012
7/21/65	.105	.013
7/29/65	.10	.012
8/5/65	.10	.012
8/12/65	.10	.013
8/19/65	.10	.014
8/26/65	.10	.014
9/2/65	.095	.013
9/9/65	.090	.013
9/16/65	.10	.014
9/23/65	.10	.014
9/30/65	.10	.014
10/7/65	.10	.011
10/14/65	.10	.012
10/21/65	.10	.011
10/28/65	.11	.013
11/4/65	.11	.013
11/11/65	.11	.013

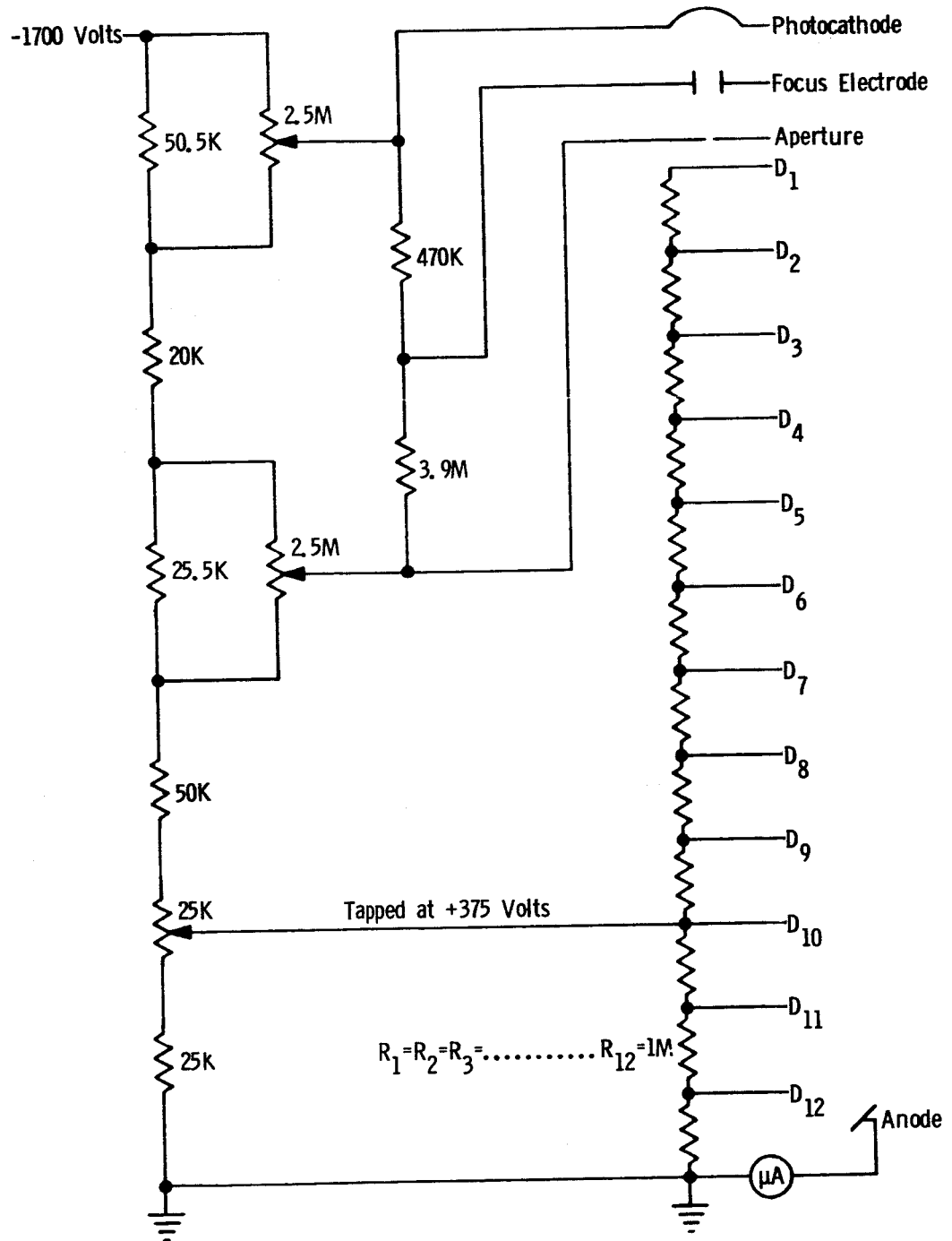


FIG. 1  
LIFE TEST CIRCUIT DIAGRAM

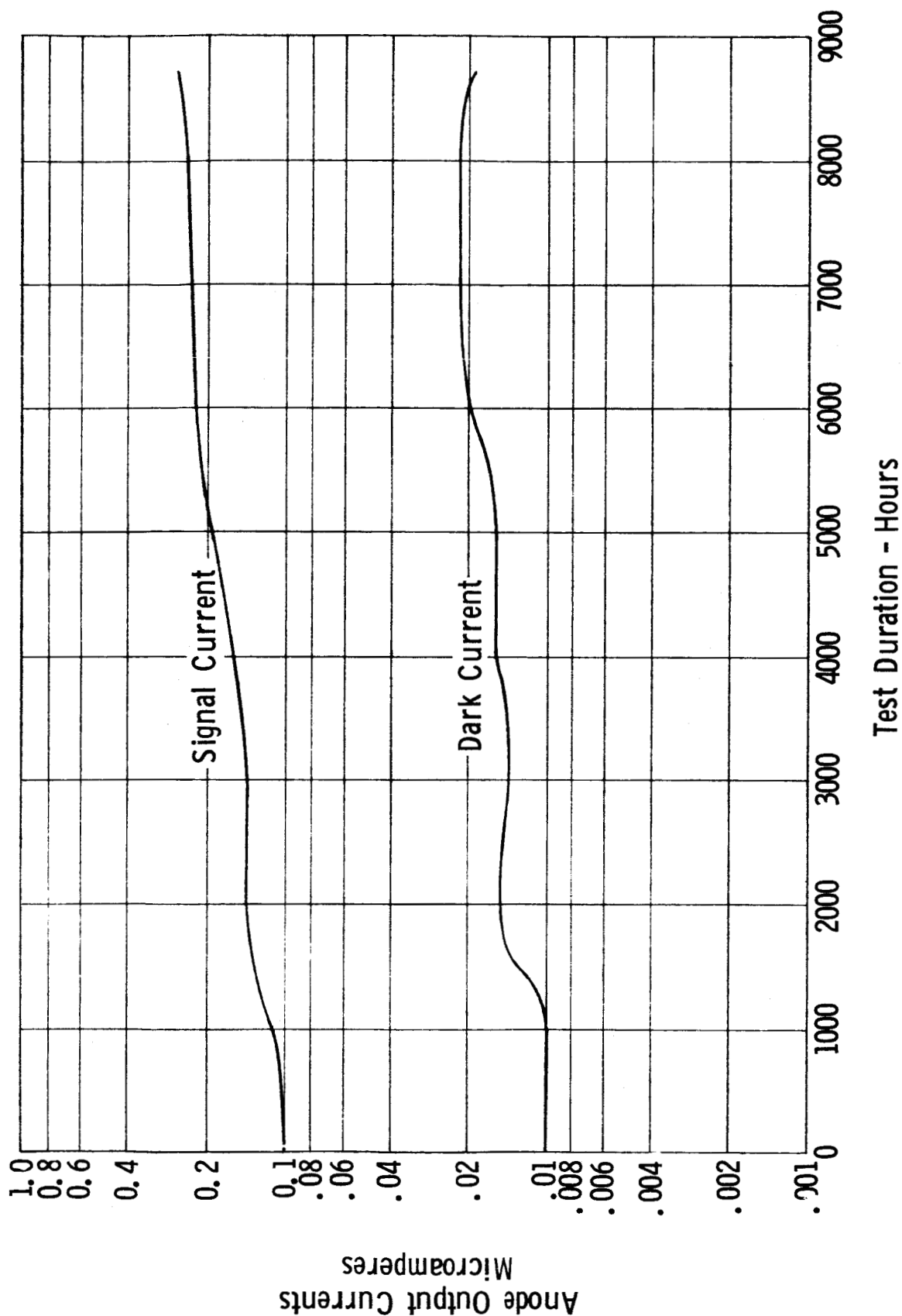


FIG. 2

LIFE TEST TUBE #M1083 (Output Currents Vs. Time)

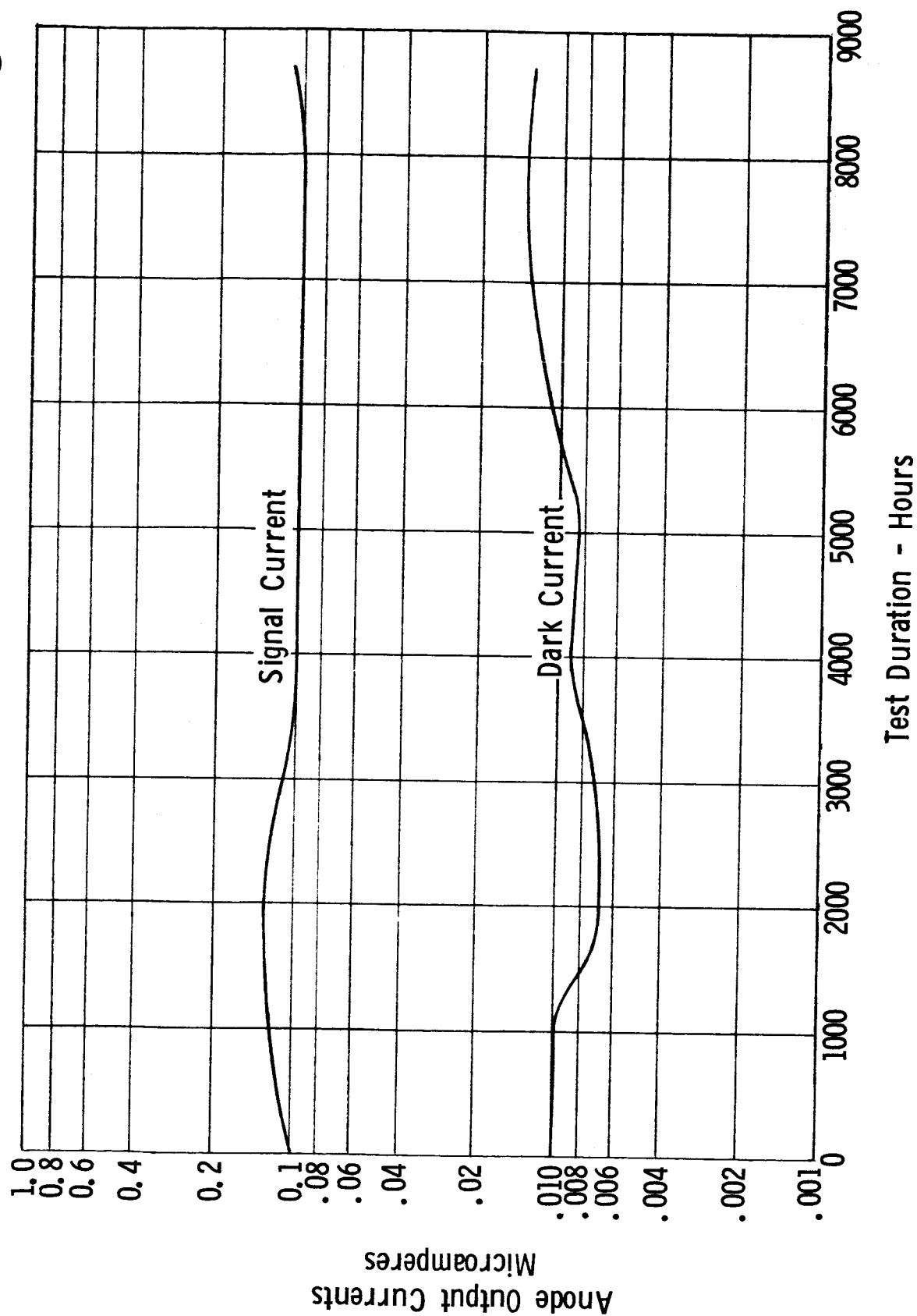


FIG. 3

LIFE TEST TUBE #M1089 (Output Currents Vs. Time)

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(Phase 9 Item 3)

ADDENDUM TO FINAL REPORT

ONE YEAR LIFE TEST OF  
1-1/2 INCH IMAGE DISSECTOR

Project No.: 5186

Date: February 25, 1966

Prepared For: Jet Propulsion Laboratory  
California Institute of  
Technology  
Pasadena, California

Prepared By: Charles E. F. Misso  
C.E.F. Misso, Section Head  
Electron Tube Department  
CBS Laboratories  
A Division of Columbia  
Broadcasting System, Inc.  
Stamford, Connecticut



Contract No. 950054

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Measurements of the overall sensitivity of both tubes at their life test operating potentials were made to further investigate the rise in sensitivity of tube #M1083 during the life test and the disagreement of the life test data with the data obtained in tests before and after the life test.

The overall sensitivity of Tube #M1083 after the life test, at its life test operation conditions, was found to be 106% greater than that of Tube #M1089.

The overall sensitivity of M1083 increased by 190 percent during the life test and that of M1089 by 10 percent.

Measurements made prior to and after the life test indicated that the increase in overall sensitivity of M1083 was 18% and that of M1089 was 39%.

At this stage it is worthwhile considering both tubes independently as follows:

Tube #M1089

Let the overall sensitivity at the beginning of the life test be 100 units. The increase during the life test was 10% i.e., the overall sensitivity increased to 110 units.

The overall sensitivity measured under standard\* test conditions increased by 39% or from 100 to 139 units.

Therefore the discrepancy at the end of the test was

$$\frac{39-110}{110} \times 100 = 26\%$$

\*(Interdynode potentials 125 volts per stage.)

This variance can be attributed to variations in optical attenuators used in the gain measurements made prior to and after the life test and to small variations of interstage potentials in the life test equipment and the standard test set.

Tube #M1083

Let the overall sensitivity at the beginning of the life test be 100 units.

A. The increase during the life test was 190 percent, that is the overall sensitivity, increased to 290 units.

B. The overall sensitivity, measured under standard\* conditions increased by only 18% or from 100 to 118 units.

Therefore, the discrepancy between A and B was  $\frac{290 - 118}{118} \times 100 = 146\%$ .

This variance cannot be attributed to normal variations in optical attenuators used in the gain measurements made prior to and after the life test, and to small variations in interstage potentials in the life test equipment and the standard test set.

If we consider only the life test data and the relative performance of the two tubes, under life test operational operation conditions, after the life test, we have the following:

\*(Interdynode potentials 125 volts per stage).

	<u>M1083</u>	<u>M1089</u>
Overall sensitivity at start of life test	100	100 units
Overall sensitivity at end of life test	290	110 units
Post life test evaluation <sup>**</sup> Relative Sensitivities	227	110

<sup>\*\*</sup>  
The overall sensitivity of M1083 as measured in the post life test would therefore be 227 units.

In approaching it this way the discrepancy is  $\frac{290 - 227}{227} \times 100 = 28\%$ .

This figure compares favorably with the 26% of tube #M1089 and the same reasons can be given for the discrepancy. This leads us to believe that our original conclusions that there was a malfunction in the test apparatus used before the start of the life test and that the before test overall sensitivity of M1083 was in error. Confirmation of this possibility was obtained in the testing of other devices after the start of the life test. Anomalous readings were obtained and an investigation revealed that one of the optical attenuators was loose and subject to movement in its mount. It is quite possible that the same condition was present when the image dissector were tested prior to being life tested.

<sup>\*\*</sup> Under life test operating conditions.